

# HD IN DISTANCE LEARNING

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## **Introduction**

For decades, students at remote sites have been educated through distance learning. Initially this involved correspondence courses and then various forms of conferencing (audio, data, and video). With the advent of the Internet, education has become more virtual, with teachers and students communicating globally and degrees being conferred without ever meeting the educators or other students. Distance learning offers: a) flexibility for the learner, b) access to increased educational resources, c) valuable global interchange, and d) equal opportunities for students and teachers regardless of location.

Educators have demonstrated global adoption and demand for advanced network applications and technologies for research and higher education through organizations like:

- Internet2 – an organization of more than 200 U.S. universities, working with industry and government to accelerate the creation of tomorrow's Internet.
- CUDI – a non-profit consortium to build and operate a Mexican high-performance backbone network for research and education; Internet2 Mexico.
- AARNet – Australia's Research and Education Network – provides high-capacity, cost-effective Internet services to the education and research communities in Australia and their research partners.
- SuperNet (Canada) connects hospitals, schools, libraries, and government buildings in Canada with affordable high-speed Internet access.

The purpose of this document is to discuss high definition video conferencing and how it can enhance the distance learning experience.

## **HD Definition**

High definition means high resolution or a large number of pixels for monitors. The original idea for high definition television came from film producers when they realized that people seated in the first rows of a wide-screen cinema enjoyed a greater level of participation in the action on the screen not possible with conventional (4 x 3 format) movies. Having the screen occupy a greater field of view, especially horizontally, significantly increases the sense of "being there". This is why the individuals behind high definition television decided that an aspect ratio for the screen should be 16 x 9.

With high definition technology the image resolution is three times better than standard television and over nine times better than traditional video conferencing. High definition video conferencing also provides cost effective, powerful new camera designs, spatial audio, and improved user interfaces.

Research has proven the effectiveness of video conferencing and distance learning. Interactive digital technologies are now recognized as tools by which educators can bring unique resources into the classroom (Schutte, 1998; Wise, 2002). Schools are breaking down the invisible walls of learning and are joining geographically distanced learning communities, allowing students to access educators in ways not possible before (Menlove, Hansford & Lignugaris-Kraft, 2000). Students involved in video conferencing are more motivated and interested in the topic and are reported to have high levels of achievement in critical thinking and problem-solving (Gernstein,

2000). Video conferencing allows for greater reach of message, since individuals may now obtain information when it is convenient for them. Video conferencing also allows for an increased number of participants and allows people who might never meet physically, yet who study or work together, to meet virtually – face-to-face over video. With video conferencing, and the instructional tools that are now used with it, all individuals who need information can get the information when it is easiest for them, on a synchronous or asynchronous basis. This is known as blended learning, which is a solution that combines several different delivery methods, such as web-based courses, collaboration software, and video conferencing. Blended learning can also mix various event-based activities, including face-to-face classrooms, self-paced learning, and live e-learning using video conferencing. Enhancing standard video conferencing with high definition only improves the benefits and increases the number of applications for which individuals wishing to meet and learn at a distance. It also allows the use of additional high definition content sharing devices like PCs, DVDs, and high-resolution document cameras.

## **Standard Video Conferencing Compared To High Definition**

To compare standard video conferencing to high definition video conferencing one needs to understand the differences in resolution, frame rates, display systems, bandwidth, audio quality, and camera designs.

### **Resolution**

Standard video conferencing systems are limited to providing 352 x 288 lines of video resolution at 15 – 30 frames per second due to computing limitations of the systems. Newer advances in processor technology enable more powerful compression/decompression architectures that provide high definition video at a resolution of 1280 x 720 lines of video resolution at 30 frames per second, which is over nine times better than the standard video quality achieved today.

### **Frame Rate & Format**

Frame rate refers to the frames that are refreshed each second. Higher frame rates mean better motion handling and higher overall picture quality. Format refers to the number of lines of vertical and horizontal resolution displayed on the screen to make the picture sharp and clear. The higher the format, the clearer and sharper the picture. The “i” and the “p” after the format refer to how the lines of resolution are drawn. Pictures are first drawn on the odd numbered resolution lines. Then the same picture information is drawn in the even numbered lines. The odd/even drawing pattern is called *interlacing*, which was developed to conserve transmission bandwidth. The *progressive scan* format is an alternative to interlacing that improves picture quality on larger screens. In North America, all high definition television (HDTV) receivers are capable of decoding 18 separate scanning formats, including interlaced and progressive formats at various picture frame rates. Progressive scanning is the norm for computer displays. High definition video displays picture resolutions of 720p at frame rates of 24, 30 or 60, and 1080i/1080p at frame rates of 24 or 30.

### **Display Systems**

A video conferencing system needs a display or projection device for maximizing visual output. Initially, video conferences were displayed on a TV set or a computer monitor. Today there are many more choices and often two or more displays are used for video conferencing. This could mean a display device for an instructor, overhead projection for students, a document camera, PCs, DVD content, etc.

When standards for high definition television were initially discussed, the aim was to double the horizontal and vertical resolution and increase the viewing angle from 10 degrees to 30 degrees

horizontally and 20 degrees vertically. This is done by going to a 16 x 9 wide screen, instead of a traditional 4 x 3 screen. Having the screen occupy a greater field of view significantly increases the sense of “being there”. The viewer experiences an increased sense of reality, and 3-dimensional depth in the picture, as soon as the viewing angle exceeds 20 degrees. Users are amazed when they first experience the nuances of expression and gestures that are visible with high definition video conferencing. For instructional purposes, the use of high definition video conferencing allows people to really SEE what they are viewing. Sciences, like physics and astronomy, become more real. Classes in music and dance can truly be appreciated. Specialized educators in healthcare can provide continuing medical education at a distance by allowing physicians and nurses to participate in remote training sessions and truly experience all the nuances of patient care at the distant end.

### **Bandwidth**

Bandwidth is defined as the capacity a telecommunications channel has to move information. Many of the standard video conferencing systems used today operate at bandwidths ranging from 128 Kbps to 768 Kbps. These ranges have historically been selected to minimize cost and because additional bandwidth was not always available. High definition video conferencing systems use a minimum of 1 Mbps of bandwidth to operate effectively, with bandwidth at 2 Mbps or better recommended to achieve premium audio and video quality and allow the use of additional high definition content sharing devices like PCs, DVDs, or high-resolution document cameras. In recent years, cost effective and plentiful bandwidth has become accessible to enterprises, educational institutions and the government.

Organizations using high definition video systems will also find the video better at any bandwidth (Cable TV quality at 384 Kbps, DVD quality at 512 Kbps, 2 times Cable TV quality at 768 Kbps, or 1 Mbps). This is important for organizations that might wish to run multiple video conferences at the same time, but cannot offer 1 Mbps to all of them. This is because HD video offers almost twice the horizontal and vertical resolution of traditional video systems which results in improved capture, process, and reproduction capabilities across the entire system.

### **Audio Quality**

While often overlooked, high quality audio is critical to the success of any video conference for without good quality audio, the image appears to suffer; and with no audio at all we are left with silent pictures! High quality audio causes less meeting fatigue because noise is suppressed. There is a natural flow of conversation due to minimal latency. (Latency is a fancy word for waiting time.) Interaction is natural because gain control means you no longer have to scream into microphones. To ensure the highest quality audio, attention must be given to microphone placement, echo cancellation, audio balancing, tone adjustment, and audio pre and post processing. Proper audio quality allows participants to “talk over” one another, as they might during an in-person meeting, and simultaneous “side conversations” can also be heard. Regardless of all the good technology, successful audio quality is also dependent on room acoustics. If a room is not properly treated (i.e. sound absorption, ambient noise, distance and direction from microphones, and speaker placement) the quality of the audio equipment will be lost.

### **Camera Designs**

In the past, high definition cameras have only been available for digital camcorders or the broadcast television market. Now that high definition is being used for video conferencing, firms are starting to develop software and technology to make high resolution cameras for high definition

video conferencing. These cameras help ensure that optimal lighting in the room matches the individuals and the environment. New high definition cameras provide greater zoom flexibility, wider degrees of viewing angles, and larger panning radius. This equates to a wider view of the room and clearer pictures.

## **User Views of HD Video Conferencing in Distance Learning**

A survey of educators, conducted as this white paper was written, indicated a wide range of applications and benefits for HD video conferencing. The respondents represented K -12, higher education, corporate training, and content provider organizations (i.e. museums, aquariums, etc.). Suggested applications, as presented by the respondents, include:

- Undersea exploration
- Scientific studies
- A variety of medical applications including medical training, on-going medical education for doctors and nurses, medical teaching,
- Science experiments/cadaver demos – anything where you need to SEE what is happening,
- Delivery of music and content,
- Video presence window between classes that need a high degree of interaction, i.e. classes in music and dance, K-12 classes bringing in a remote student or students, university classes involving remote instructors, students or content providers
- Art history classes sharing detailed pictures, artifacts, documents to remote students
- Science researchers for collaboration
- School administrators for high-level meetings,
- Hearing impaired classes, and
- For all of the above, improved ability to share documents, pictures, full motion video, etc.

The users feel there are many more potential early-adopter applications for high definition video conferencing and as the technology is deployed and the benefits are discovered, the value of high definition video will result in everyone wanting it as part of their video offering to truly experience what is happening at a distant site.

“Manhattan School of Music uses HD video conferencing technology to teach talented young musicians for tomorrow’s stage. Training students for the world’s concert halls and classrooms requires high-fidelity audio, broadcast quality video, and 3-dimensional presentation to effectively achieve true improvements and results. Without these features, training on this level would not be possible”, states Christianne Orto, Assistant Dean of Distance Learning and Director of Recording.

“Leaders in the Internet2 community have been researchers in “big science”, like astronomy and physics, followed by specialized educators in health care and the arts. Masters classes in music and dance are now taking place between students and teachers who would previously never encounter one another. One organization after another is discovering how to get real value out of conferencing, thanks to dramatically improved quality.” noted Dr. Jonathan Tyman of Intenet2.

Jamie Diana Poindexter, Manager of Teleconferencing Operations at the University of Wisconsin, stated, “There are applications out there that can benefit from the higher resolution that HD will provide, so we are keenly interested in becoming experienced in HD so we are ready to support our users.” One application is undersea exploration, as if one were in a submarine using underwater robots to deliver HD cameras to hot water vents on the Pacific ocean’ floor so viewers can observe living plants and animals that don’t exist elsewhere. Research scientists located at university laboratories around the country are studying fusion and plasma and share their high-resolution demonstrations and findings using HD video conferencing.

What makes high definition video conferencing most attractive to these respondents is the 3-dimensional depth of the picture, outstanding audio quality, and high definition content sharing. What makes the technology least attractive is the lack of interoperability with standard video conferencing systems and the cost. However, it is important to note that many educators are using grants to obtain needed funding for HD in order to remain competitive. Alan Phillips, Videoconferencing Coordinator for the California K-12 High Speed Network stated, "Areas such as science and special needs (hearing impaired) are what is going to drive the need for HD in K-12 education".

Dr. Tyman added, "Users are amazed when they first experience the nuances of expression and gesture that are visible in a high definition video conference. The full range of emotions comes through with the enhanced color depth and high-fidelity sound. This is astonishing to those numbed by years of communicating by telephone."

## **Polycom® UltimateHD™**

Given the breadth and depth of applications where video conferencing, and now HD video conferencing, can be used to provide value, Polycom brings to market a solution that addresses all of those applications. It is not enough to just provide an HD resolution and high frame rate. A true HD experience needs to take into consideration every aspect of the video meeting and provide an "UltimateHD" experience.

Polycom® UltimateHD™ is a next generation architecture that enables the world's most lifelike and engaging collaborative communication experience. Polycom's UltimateHD architecture is a long term strategy that conceptually describes the essential elements (HD voice, HD video, HD content sharing, HD infrastructure, HD services) and how they blend to enable remote meetings to be as engaging as face to face meetings, dramatically improving productivity and efficiency.

## **What does the UltimateHD architecture provide?**

UltimateHD products and solutions based on this architecture will provide users the greatest visual, audio, and content detail in a multimedia collaborative meeting.

- **Enhances productivity, effectiveness, and efficiency** - an engaging life like experience with superior audio fidelity, video clarity, and detailed content that allow you to manage globally dispersed teams, speed time to market and build loyal relationships over distance
- **Facilitates a new class of Unified Collaboration applications**- applications that require the enhanced detail supported by UltimateHD where you used to have to be there are now possible remotely
- **Ensures a lifelike user experience everywhere**- consistent premium experience from mobile, desktop, and conference room
- **Enables the next generation of unified collaboration**- conferencing, broadcasting, streaming and archiving
- **Becomes the collaboration core of any unified communications strategy**- leverages and enhances incumbent infrastructure telephony and presence based systems
- **Provides unmatched flexibility**- Supports simultaneous On-Demand or scheduled HD collaborative meetings
- **Delivered without compromise only Polycom** - Can provide all of the essential elements with Best in class HD Voice, HD Video, HD Content, HD Infrastructure, HD Services

## How is Polycom's UltimateHD architecture different from what competitors offer?

In order for customers to have a complete and consistent life-like collaborative communications experience everywhere, the technology must be approached from a strategic and holistic level. Unlike other solutions claiming high definition, which only focus on delivering the requisite video resolution, Polycom HD solutions adhere to the UltimateHD architecture enabling a complete high definition experience with every aspect of the meeting enhanced by UltimateHD architecture conformity: HD video as well as HD voice, HD multimedia content, HD bridging, HD recording/archiving/streaming, and supporting HD services.

## What An Ultimate HD Distance Learning System Will Look Like

To optimize the HD Distance Learning experience, the following should be kept in mind:

1. *A data transfer rate of 1 Mbps is the minimum requirement* for high definition interactive video conferencing. For optimal results, data transfer rates at or about 2 Mbps are recommended. This provides incremental bandwidth for premium audio and additional content sharing devices such as PC input, DVD's or high-resolution document cameras.
2. *Quality of Service (QoS) for the network is a must* to ensure consistent performance for the duration of the call. Current detractors for video conferencing are related to QOS issues – packet loss, video tiling, choppy audio, etc.
3. *High definition video conferencing requires that all endpoints be HD-compatible* in order for any of the video conference participants to take advantage of the high definition video experience. However, it is important to note that HD video makes every unit look better, even if not fully HD compliant.
4. To capture high-resolution images, *a camera that supports true high-definition (minimum 720p) in the 16:9 format is required*. Ideally, the camera should come from the same manufacturer as the video conferencing endpoint. This will ensure that the camera and endpoint have been optimized for providing the best end-to-end high-definition video conferencing experience.
5. *High-definition video monitors (LCD, Plasma, or DLP) must also support a minimum of 720p horizontal lines of resolution*. The monitors should offer connectors that enable optimal high-definition signals. Correct monitor selection will also require matching the size of the room and the average distance participants will sit from the monitor.
6. *A high-definition Multipoint Control Unit (MCU) is required for bridging all of the calls together*, when more than two parties plan to participate from different sites (endpoints). Of course, *the MCU must also support true high-definition (minimum 720p) and a sustained 30 frames per second*, to deliver the same quality experience provided in point-to-point calls. Purchasing an MCU from the same manufacturer as the video conferencing endpoints is highly recommended to ensure optimal end-to-end performance. Finally, the MCU should be standard-based (H.264) for interoperability and scalable to allow as many connections as required for multipoint calls.

## Summary

The future for HD in Distance Learning is bright. There are applications that can benefit from the higher resolution that HD provides. These include anything where the visual experience is imperative to the learning experience (i.e. studying the details of a plant or animal, looking at the dynamics of nature, reacting to human interaction, etc.). Dynamic changes in the global communications environment – decreasing network and equipment costs, increased deployment of bandwidth, and the desire to explore things globally – will help propel the adoption and usage of high definition video conferencing at an ever accelerating rate.

UltimateHD from Polycom allows educators to be more successful by providing HD voice, HD video and HD content sharing. HD voice allows sounds to be heard in noisy environments, handles dialect differences from multinational participants, and allows large groups to easily converse with multiple speakers. HD video means facial expressions can communicate as much or more than words, and primary cameras may be used to show in-room content, show and tell, and demonstrations. HD content sharing means multiple cameras, full-motion HD DVD footage, and PC interfaces can result in enhanced viewing of all types of materials. It is now easy to record, stream and archive video conferences and multimedia content, which broadens applications for conferencing and collaboration solutions.

The following chart provides a sample summary of how HD video conferencing can add value to educators in K-12, higher education, corporate training, and content providers (museums, aquariums, etc.). Clearly, the technology now exists to allow people, regardless of location, to use their imaginations in finding ways to learn from others and teach others.

<b>K-12</b>	<b>HIGHER EDUCATION</b>	<b>CORPORATE TRAINING</b>	<b>CONTENT PROVIDERS</b>
Interfacing with students globally to learn about other cultures.	Have access to professors having expertise in subjects at available locally.	Video Presence window between corporate sites to allow live, ongoing interaction at a moments notice.	Learning about zoo animals and taking part in their daily activities and growth.
Record, stream and archive class sessions to review at a later date and share with others.	Allow college administrators to oversee activities at multiple sites without the need to travel.	Sharing the expertise of subject matter experts and viewing their facial expressions in reaction to questions posed by customers.	Studying creatures at aquariums and seeing how they survive in their habitat over a period of time. Discussing these animals with the biologists who work and live with them on a daily basis.



## **About TRI**

Telemanagement Resources International Inc. (TRI) is a 24 year old management consulting firm specializing in marketing, communications, and training with an emphasis on design, assessment, project management, promotions, and training for collaborative conferencing systems. More information about TRI can be obtained at [www.TRIInc.com](http://www.TRIInc.com).

## **About S. Ann Earon**

S. Ann Earon has been a researcher and consultant in multimedia communications for 24 years. She holds a Masters in instructional technology and educational administration from Northeastern University, and a Ph.D. from Boston College in business, speech & communications, and education. Dr. Earon currently chairs the Interactive Multimedia & Collaborative Communications Alliance (IMCCA), the non-profit industry association for conferencing & collaborative communications. She can be reached at [AnnEaron@aol.com](mailto:AnnEaron@aol.com).

## **About Polycom**

Founded in 1990, Polycom delivers end-to-end rich media collaborative applications for voice, video, data and the web from desktop and mobile personal systems to room systems to the network core. Our vision is to enable people to connect anytime, anyplace and with any device in a virtual experience as natural as being there. Polycom is the worldwide leader in market share for best in class group and personal video systems, video and voice collaboration infrastructures and conference phones. For more information, visit [www.polycom.com](http://www.polycom.com)